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Context and reinterpretation of reported redfish catch in Unit 1+2 in the 1980s and 1990s based on interviews with industry participants

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Previous model fitting exercises have revealed difficulties reconciling catch data with declines in biomass for Unit 1+2 redfish in the late 1980s and early 1990s. A series of interviews with redfish fishing industry participants from the 1980s and 1990s was conducted primarily to show how fish was caught, how much was caught and what was the composition of the catch at this time. Quasi-quantitative indicators of total fish catch and composition were determined from these interviews and suggest that the DFO reported catch data may underestimate total catch in this period by more than a factor of 2. Catch composition reported to DFO from this period shows only a very small percentage of fish <20 cm while these indicators suggest that 45-76% of the catch abundance in this period may have been constituted by fish <20 cm. It is assumed that because none of the fishermen's activities were prohibited during this period, and the fact that most have long since left the fishery, this information may be relatively unbiased. It is not suggested that reported catch data should be modified based on information from this study. This study is still too much of a patchwork of non-randomly sampled information to be considered a valid quantitative means of correcting these data hence the term quasi-quantitative is used throughout the document to describe the indicators developed here. Despite not being able to correct catch data using this study, the present work provides context for interpretation and possibly constraining model fitting results for this period.

Contexte et interprétation des captures de sébastes déclarées dans les unités 1 et 2 dans les années 1980 et 1990 sur la base d'entrevues avec des participants de l'industrie

RÉSUMÉ

Les exercices antérieurs d'ajustement des modèles ont fait ressortir des difficultés de rapprochement des données sur les prises avec la diminution de la biomasse pour le sébaste des unités 1 et 2 à la fin des années 1980 et au début des années 1990. Une série d'entrevues avec des participants de l'industrie de la pêche au sébaste dans les années 1980 et 1990 a été réalisée, principalement pour démontrer comment le poisson était capturé, la quantité prise et la composition des prises à cette époque. Des indicateurs semi-quantitatifs du nombre total de poissons et de la composition des prises ont été déterminés à partir de ces entrevues et portent à croire que les données sur les prises déclarées au MPO sous-estiment d'un facteur supérieur à 2 les prises totales pendant cette période. La composition des prises déclarées au MPO lors de cette période ne montre qu'un très faible pourcentage de poissons de moins de 20 cm, alors que ces indicateurs donnent à penser que 45-76 % de l'abondance des prises auraient peut-être constituées de poissons de moins de 20 cm. Il est supposé que puisqu'aucune activité de pêche n'était interdite à cette époque, et compte tenu du fait que la majorité des pêcheurs ont cessé leurs activités depuis, cette information peut être relativement impartiale. Il n'est pas proposé de modifier les données sur les prises déclarées en fonction de l'information découlant de cette étude. Il y a encore trop de données échantillonnées non aléatoirement et non classées pour que cette information soit considérée comme une moyenne quantitative valide en vue de corriger ces données, d'où l'utilisation du terme « semi-quantitatif » dans le document pour décrire les indicateurs établis ici. Même s'il n'a pas été possible de corriger les données sur les prises au moyen de cette étude, les présents travaux fournissent un contexte pour interpréter les résultats et peut-être limiter l'ajustement des modèles pour cette période.

INTRODUCTION

During the period 1985-1994, Canadian east coast groundfish fisheries were undergoing a large transition (Hutchings et al. 1997). The rapid decline in abundance of cod stocks resulted resulting redistribution of fishing capacity into other fisheries most notably into redfish, *Sebastes spp*. This occurred throughout the east coast but the Gulf of St Lawrence (now Unit 1), 3P and 4Vn (now Unit 2) experienced large increases in fishing effort during this period (Goetting 2008).

Redfish were not as valuable as cod but considerable profits could be made fishing redfish as they were easier to catch than cod for the same effort. Redfish tend to congregate in a large bottom and midwater clusters in spring and fall and 1 hour of trawling could on occasion yield a 50,000 kg tow. This meant that redfish fishing could be profitable even with low prices compared to much better prices for cod at the same time. Prices also varied regionally and seemed to be highest from Nova Scotia while lower in PEI, then Newfoundland and lowest in the Magdalen Islands which is likely a reflection of the difficulty of getting fish to market. This difference in prices may have set up a slightly different incentive structure for fleets out of different ports in terms of amount and sizes of fish landed.

Redfish in this region at this time were relatively abundant due to the strong year classes present from 1972 and 1980/81 and a large year class in 1988 and a lesser one in 1985 (Valentin et al. 2015) may have suggest at the time that the increased fishing mortality was not leading to recruitment overfishing. The result was that total allowable catches (TAC) were not restrictive and there were few restrictions on small fish catch or on fish in mating aggregations in the fall and fish ready to release live larvae in the spring. The lack of restriction on the fishery meant that major investments in new large steel hulled vessels was made by the industry as late as the early 1990s to increase redfish catches.

DFO catch statistics from this period do show large increases in catch but perhaps are an underestimate of both the total catch and size distribution of catches during this period given the large unrestrained effort during this period. Here, rough statistics and information developed from interviews with industry participants during this period have been compiled. We do not attempt to present this as a way to correct reported catch but this information is valuable in aiding interpretation of catches, stock status and assessment model output for this period. Analyses have shown previously that understanding redfish dynamics during this period is key to understanding current redfish stock production and can have a large influence on developing realistic projections and setting reference points for the stock going forward.

METHODS

The term "fishermen" is used throughout the document in reference to these industry stakeholders as a general term. Some of the industry stakeholders were crew on boats, others were skippers and others worked in processing plants. No women were interviewed as none were found as contacts and therefore we did not use a gender neutral term.

ESTABLISHING CONTACTS

In September 2015, the author wrote a letter to the editor of The Navigator magazine asking for anyone who fished redfish in the 1990s or before in Unit 1+2 to get in touch with him to share their observations of the fishery. From this two responses were received, the first being an inquiry into the current state of redfish and the second being a fisherman out of Souris, PEI in the 1980s and 1990s. This interview provided a considerable amount of information and another contact. Jason Spingle of the Food, Fisheries and Allied Workers (FFAW) put me in touch with

redfish fishermen on the west coast of Newfoundland. In the case of the Gaultois, NL, the local hotel was called and reception asked who would be around that knew about redfish in that period as it was known that Gaultois was a large redfish processing facility in the 80s and 90s, the receptionist's father provided to be a valuable source. Kevin Squires of North Sydney, NS, provided a contact and possible leads for Cape Breton industry stakeholders.

INTERVIEWS

Interviews were relatively free form allowing the fisherman to discuss his observations of the fishing, operations, catch, processing and prices. At points during interviews, questions were asked to try to glean particular types of information such as:

- How big was the vessel you fished?
- What was the hold capacity of your vessel?
- What gear type did you use?
- Was all the catch landed?
- Where did you land most of your catch?
- Did you fish all year long or for how much during a year?
- When did you fish?
- Where did you fish?
- What was your weekly/annual catch at different periods?
- Was the catch composition different between periods?
- Could you roughly estimate the proportion of your catch which was large fish vs small fish?
- Were the differential prices for your catch based on size composition?
- Do you know what happened to the fish once it was taken in at a plant?

All fishermen were told that the purpose of this work and interview was to try to better understand the nature of the fishery and catch in this period and that the model fittings which have been tried on this stock to date, have issues reconciling population trends and catch trends in this period. Fishermen were asked if they minded if their names were used in the present document.

The present study is not promoted as a thorough or methodologically ideal survey of fishers in a social science sense. However, it is the not the purpose of this study to analyse these data in a social science statistical way. Also, there is a trade-off between the formalisation of such an interview and increasing the chance of gaining unforeseeable insights by allowing a freer flow of recollections. Furthermore, a more formalised approach to this would likely mean that several fishermen would be unwilling to embark if only because of the time and complication of such a process.

ANALYSIS

Location of response is shown on a map (Fig. 1). In cases where quasi-quantitative information was provided, an estimation of catch was made for comparison with DFO data. General observations of fishers is also noted where a common theme was found and where a contrast between fishermen from different locations was noted.

RESULTS AND DISCUSSION

INTERVIEW GROUP

A total of 10 fishermen were interviewed for the present study. These fishermen cover a large area of the Unit 1+2 fishery of the 1980s and 90s (Figure 1, Table 1). Probably the two largest centres for redfish processing (Souris, PEI and Iles-de-la-Madeleine, QC) were captured through interviews. In addition, fishermen operating on large boats as crew and skipper as well as small boats as owners and finally as processing plant workers were covered in the range of fishermen interviewed. It is recognised that the interviews may not cover all the important processing ports where other industry participant views may have been found. For example in Caraquet/Shippagan, NB, Burgeo and Ramea, NL, and Canso and Lunenburg, NS; nevertheless, most of the fishing areas were covered by this and it is suspected that this might only increase the absolute scale of catches but unlikely its composition or when the catch was fished.

Table 1: fisherman number, location, date of interview and fishery role of fishermen surveyed in the present study.

Fisherman number	Fisherman's present location	Date of interview	Role in the fishery in 1980s and 1990s
1	Souris, PEI	15 January 2016	crew on large (80 ft) trawler
2	Souris, PEI	18 January 2016	processing plant worker
3	Gaultois, NL	22 January 2016	refrigeration in plant and trawler crew
4	North Sydney, NS	8 February 2016	crew on large (125 ft) trawler
5	Anchor Point, NL	9 February 2016	65 ft trawler skipper
6	Benoits Cove, NL	9 February 2016	65 ft trawler skipper
7	Isle-aux-Morts, NL	12 February 2016	65 ft trawler skipper
8	Souris, PEI	12 February 2016	55 ft trawler skipper
9	Souris, PEI	12 February 2016	shore skipper
10	Iles-de-la-Madeleine, QC	15 February 2016	crew and skipper on large (125 ft) trawler

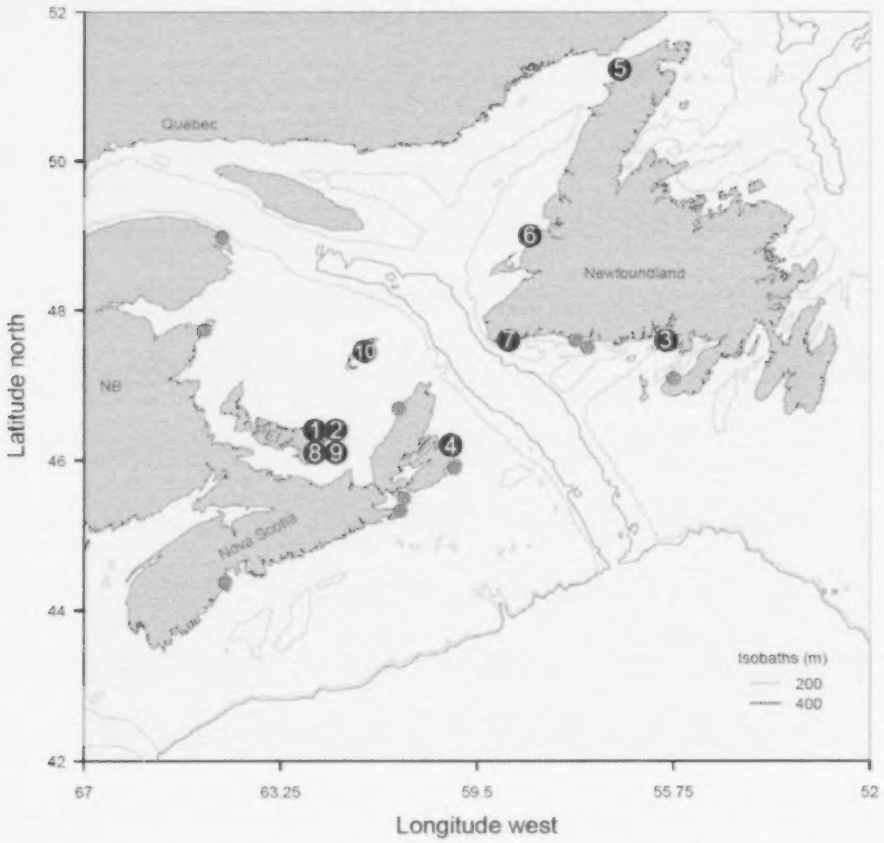

Figure 1: Map of the area encompassing redfish management areas Unit1+2 and location of fishermen interviewed in this study (Blue dots with fisherman number). The red dots represent possibly important redfish processing areas for Unit 1+2 redfish in the 1980s and 1990s but were not included explicitly here through an interview of a fisherman who landed fish primarily at that port. In several cases though, catches landed in these ports may be partially represented by the interviews here, for example Burgeo and Ramea, NL are likely partially represented through the boat count on the 65 ft fleet.

QUASI-QUANTITATIVE CATCH INFORMATION

Total catch

Questions related to annual catches were quite well known to boat operators as well as shore based processors. The cost per pound of fish was easily recalled by all fishermen as well as their normal annual catch weight. This proved to be useful information which could be used to roughly derive catch levels for different periods. When interviewing the 65 ft owner/operators, they could roughly come to an idea of 60 boats like those operating off Port-au-Basques in that period and then declining to 6 boats (Table 2).

Table 2: summary of information from interviews with fishermen that could be used to derive quasi-quantitative information on catch and catch composition in the 1980-1995 fishing period on redfish (Sebastes spp.) in Unit 1+2. More significant digits are reported than would be expected from such an analysis but these values reflect conversion to metric from imperial units and therefore significant digits are high to allow back conversion to their original units.

Fisherman number	Base information	Pertains to	Quasi-quantitative summary	
			Total catch	Catch composition
1	68 t average capacity over all vessels 3Pn, 4Vn, 40 trips per year, 17 boats, 10% of fish biomass was <20 cm; no discarding	Mostly 3Pn 4Vn	46 240 t/year, 1980-1993, especially 1986-1993	important catches of individuals < 15 cm
2	plant processes an average of 317.5 t/week; plant processed about 35% of all redfish caught in region; 20% of fish by weight < 15 cm, no discarding	4T 3Pn 4Vn	47 097 t/year, 1980-1993, especially 1986-1993	important catches of individuals < 15 cm
3	plant processed an average of 317.5 t/week; plant operated 9 month per year; by 1991 and after, 50% of fish biomass <17.5 cm and went to meal, no discarding	mostly 3Ps but some 3Pn and 4R	12 383 t/year 1986-1994	important catches of individuals < 17.5 cm
4	Average hold capacity of boats 181.4 t; half time spent fishing in 3NO and half in 3Pn, 4R; 10 boats, 12 day trips 2 days in port, fished all year, no discarding	3Pn 4R	23 650 t/year 1986-1993	unimportant catch of small fish
5	Boat landed 907 t/year; 6 65 ft boats fishing 1992-1995	3Pn 4R	5 443 t/year 1992-1995	unimportant catch of small fish
6	Boat landed 907 t/year; 60 65 ft boats 1986-1992, 6 65 ft boats fishing 1993-1995	3Pn 4R	54 420 t/year 1986-1992, 5 443 t/year 1993-1995	unimportant catch of small fish
7	907 t/year per boat, 60 65 ft boats 1989-1993	3Pn 4R 4S	54 420 t/year 1989-1993	unimportant catch of small fish
8	907 t/year per boat, 60 65 ft boats 1990-1995, 6 boats after 1995	3Pn	54 420 t/year 1990-1995, 5 442 t/y after 1995	unimportant catch of small fish
9	Plant processed 16 329 t/year 1989-1993	4T 3Pn 4Vn	16 329 t/year 1989-1993	unimportant catch of small fish
10	Plant operated 5*125 vessel.1*110 ft vessel from early 1980s -1993; 81-85 one 125 ft landed 2 721 t/year and 110 ft landed 2 267 t/year; from 1986-1987 each landed twice as much as earlier period; from 1988-1994, 50% discarding rate by weight at sea for fish <20 cm.	4RST and some 3Pn 4Vn	18 185 t/year 1980-1985; 36 287 t/year 1986-1987; 72 575 t/year 1988-1994	important catches of individuals < 20 cm

This, however, seems to apply mostly to the Newfoundland based fleet while there was some 65 ft effort from elsewhere. The larger trawler operators were more certain about the exact numbers of large vessels fishing and their home ports. Processing plant workers often had a good overview of total catch processed as well as size composition and what happened to the catch once graded. Plant workers in some respects give a more inclusive overview of the catch given that most of the catch funneled through the plants.

Plant workers revealed the changes in size composition of landed catch over time from relatively large fish until about 1985 with progressively decreasing fish sizes thereafter and by the 1990s more than 50% of the catch weight was constituted by fish <15cm. All these small fish went straight into fish meal along with the filletted carcasses of larger fish. It is not clear if the small fish that went straight to meal were reflected in overall catch statistics reported to DFO or not. There is a good chance that for some ports because small fish were treated in the same way as carcasses, that their biomass was not reported in total catch statistics. Plant workers were also quite aware of the efficiency of the processing operation ranging from 32-34% of fish going into filleting machines (supplemented by hand cutting) coming out as frozen product by weight. It may well be that reported catch was the just the sold product bumped up by this processing efficiency.

On the whole, few fishermen reported discarding as a common practice. Fisherman 1 reported that vessels never came home empty and if only a small amount of fish was needed to max-out the vessels capacity then another haul was made and excess was dumped. Given the short duration of some trips (2-3 days) and year long fishing this could have amounted to an important biomass of fish. Fisherman 10 noted that prices for small fish were so low, especially by the 1990s, and small fish were so dominant in the catch that a discarding rate by weight of 50% (2 hauls to get one good one) was standard. A small fish in that case being about 20 cm.

With these observations and caveats, a catch from each fisherman's recollection was calculated. Sometimes this applies only to a single boat, other times to a port and sometimes to a much larger part of the Unit 1+2 area.

The 65 ft fleet landed just over 900 t (2×10^6 pounds) each per year from about the mid-1980s until 1994 while the large vessels (>38 m, 125 ft) landed about six times as much (5 443 t or 12×10^6 pounds) (Table 2). In the earlier period from about 1980-1985 catches were about 50% those of latter period but the latter period involved more discarding and meal production owing to more small fish.

A rough calculation of minimum likely catch (Figure 2) was done by summing the estimates from selected responses. The goal of this was to try to cover as much of the catch as possible without double counting:

- Fisherman 3, Gaultois, NL who described total processing plant incoming product
- Fisherman 4: North Sydney, NS who described large boat capacity, number of boats and number of trips and proportion of time fishing in Unit 2
- Fisherman 6: Benoits Cove, NL who described the Newfoundland 65ft fleet size and annual landings per boat
- Fisherman 9, Souris, PEI who described total processing plant incoming product
- Fisherman 10, Iles-de-la-Madeleine, QC who knew boat capacity, number of boats and number of trips as well as total processing plant incoming product

This calculation suggests that in the early 1980s catch was about 54 kt, peaking at about 180 kt in the first three years of the 1990s and then dropping quickly thereafter. This is called a minimum likely catch for several reasons:

- it may not include landings at ports such as Lunenburg and Canso, NS
- it does not include landing at ports in Shippagan/Caraquet, NB or Riviere-au-Renard, QC, Louisbourg, Petit-de-Grat and Cheticamp, NS. The Shippagan fleet in particular consisted of at least two large (125 ft) vessels which could have taken many fish (i.e. M-d-I boats of the same size took 5 443 t/y each)
- It probably only captures a portion of the fish landed at Burgeo, Ramea and Grand-Bank, NL
- Some fleet sectors report no catch or discarding small fish while other fleets fishing at the same time and sometimes in the same area report discarding rates up to 50%.

These estimated values for minimum likely catch are quite similar to reported catch in the first half of the 1980s (Figure 2) but by 1990 they are more than twice the reported catch and if correct would be the highest catches since statistics were kept in 1960.

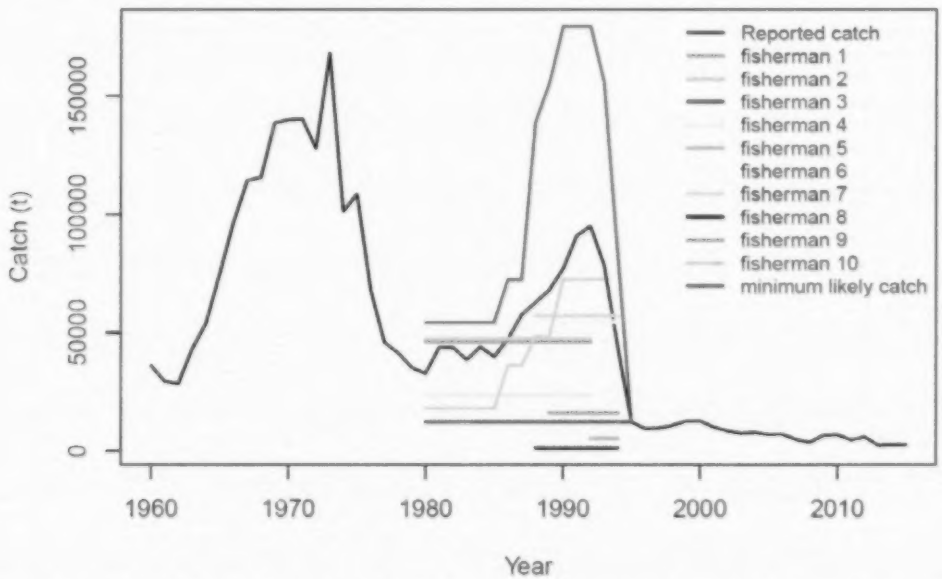

Figure 2: Reported redfish catch in Unit 1+2 as well as catches reported by the fishermen interviewed for this study. All the individual fisherman values represent only portions of the catch of the stock while the minimum likely catch represents the sum of catches reported by fishermen 3, 4, 6, 9 and 10 and is a rough minimum for global Unit 1+2 catch.

Composition

Though reported total catch is quite different than the minimum likely catch for the late 1980s to early 1990s period, it is the catch composition which is perhaps more profound. DFO catch statistics shows only a very small percentage of catch abundance of fish < 20 cm (Figure 3), peaking at 2.5% in 1993 and with a lesser peak in 1987 at 1.4%. Fishermen 1, 2, 3, 10 reported that from about 1986-1990 about 20% of the catch by weight was made up of fish <20 cm and after 1990 this was as much as 50%. An assumption was made from this that a large fish (>20 cm) had a mean length of 23 cm and a small fish (<20 cm) had a mean length of 15 cm. If

this were somewhat close to the reality of the catch, then it would suggest that actual catch abundance composition would have been about 48% small fish (<20 cm) from 1986-1990 and 79% small fish from 1990-1995 (Figure 3).

Clearly the redfish catch composition data held by DFO for Unit 1+2 do not properly account for the amount of small redfish actually killed in fishing operations in this period.

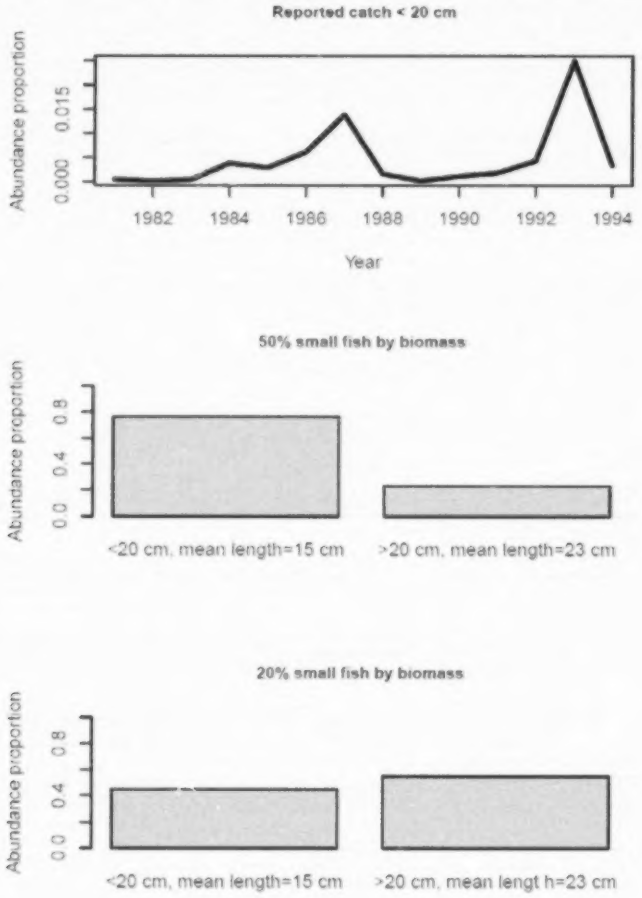

Figure 3: top panel: proportion of reported catch abundance <20 cm; middle panel: proportion of catch abundance <20 cm if 50% of catch biomass is <20 cm; bottom panel: proportion of catch abundance <20 cm if 20% of catch biomass is <20 cm.

GEAR SELECTIVITY AND DISCARDING

All of the fishermen noted that there were large changes in gear technology and fishing methods in this period. Traditionally, the redfish fishery was conducted with a bottom trawl and this continued up until the mid-1980s. However from the early 1980s the midwater "diamond" trawl was commonly used which at least doubled catch rates over the bottom trawl. In addition, bottom trawl fisheries were often not very efficient at night and resulted in more by-catch such that sometimes fishing operations were only conducted during daylight hours. The best bottom trawl catches of redfish seemed to occur between 11:00 and 14:00. In 1986, however, many of the larger boats began using what was referred to as the "Turbo Trawl". This piece of gear seemed to be 5-10 times more efficient than the bottom trawl and could be successfully fished

24 hours per day. This trawl was clean in terms of by-catch but owing to the fact that it was a midwater trawl, it likely had a greater selectivity for smaller redfish which tend to be more aggregated in the water column than along the bottom at all times of day (McQuinn, DFO, Mont-Joli, pers. comm.).

Also by 1986, the cod fishery in the Gulf had peaked and was on a quick decline and much of that effort started moving into the redfish fishery. This coincided with year round fishing for most operations. When the Gulf (Unit 1) became too icy, fishing effort moved mostly to 3Pn and 4Vn. For the plant in Souris, PEI, the harbour became too full of ice for boats and those boats would land their catch in Mulgrave, NS at that time and truck it to Souris for processing.

It appears that a change in fishery selectivity may have occurred around 1986 for several reasons:

- An increasing capacity in the redfish fishery by adopting the declining capacity of the cod fishery
- Introduction of highly efficient midwater trawl gear which allowed 24 hour fishing and possibly greater selection of smaller fish that were more concentrated in midwater
- A year-round fishery with much of the effort from the Gulf moving into 3Pn and 4Vn in winter

After 1994, it is likely though that selectivity changed again owing to the dismantling of much of the mobile groundfish fleet especially in Unit 1.

Other observations of fishing and processing operations

Most fishermen noted that at the time, they were uncomfortable with the amount and kind of fishing being allowed on redfish but because it was a competitive fishery they felt there was little that could be done by individual actions. All noted the "devastating" effect of the introduction of midwater trawl on the redfish stocks. Also noted was fishing on aggregations of fish in the spring that were releasing larvae. During that time of year, the decks and holds of boats would have large amounts of spawn in them. Occasionally they were instructed to move elsewhere but sometimes this just displaced effort to small fish. Because price differentials for catch based on composition began to be introduced in the late 1980s, an incentive for discarding was set-up. This was not because quotas were limiting, just that it was not worthwhile bringing back low value product to port. This was particularly true for the Iles-de-la-Madeleine where prices were lower than elsewhere and therefore there was perhaps a greater incentive to discard.

Fishermen reported knowing how and where to select larger fish although those areas may not produce large yields. Given the ease of sometimes just taking a large trawl full of mixed fish with only a 15 nautical mile steam to port (Port-aux-Basques) this seemed to be a normal practice rather than being overly selective, though the 65 ft fleet which largely operated in that area did not report catching many small fish.

Impact on population trends

This work suggests that catch of both species of redfish may have been much larger than reported in the 1980s and 1990s and especially in the period 1986-1994. It is known that there were good year classes of *S. mentella* (SM) from the early 1970s and early 1980s and these likely supported the large-fish fisheries in the late 1980s. These fish, however, became quite scarce by 1990 while there were good year classes of small *S. fasciatus* (SF) from 1985 and 1988 in the water. It may be that the heavy fishing effort beginning in 1986 fairly quickly removed the the larger mature SM from the stock area while captures of young fish (many < 20 cm) in by 1990 primarily affected SF. One of the enigmas of redfish in this area is

the phenomenon of "disappearing" cohorts of SF (Valentin et al 2015). That is, SF cohorts tend to be present in the Gulf until age 3-4 and then are no longer found in the Unit 1+2 area but appear as larger fish on the edge waters of the Grand Banks (3LNO) (Gascon 2003). The 1988 year class of SF is one of these cohorts (Morin and Hurtubise 2003). By 1993, the 1988 cohort of SF is hardly apparent above the background numbers of five year olds in the Gulf (Morin and Hurtubise 2003). Interestingly though, Fisherman 3, who represents a large part of the catch from Hermitage Channel, reports much larger numbers of small redfish in the 1990s. Power (2003) also cites the paucity of log book data for the Hermitage Channel area. This increase in small redfish catch in Unit 2 at the time that those redfish disappeared from Unit 1 and a lack of log-book information to contradict it suggests another hypothesis on the disappearance of the 1988 year-class of SF: much of this year class could have been caught and discarded or caught and landed for fish meal at a young age before it appeared as larger adults in the fishery though some of this cohort did appear later in 3NO.

CONCLUSIONS

This study shows that care should be exercised in interpreting catch of redfish in the Unit 1+2 area in the 1980s and 90s. At this time there were many changes in capacity and technology which promoted a very efficient fleet and increasing effort directed at redfish coming from the declining cod fishery and quotas and fishing seasons were not restrictive.

It is not recommended that total catch or composition for this period should be corrected quantitatively from the information gleaned from fishermen reported here; still, this information can prove valuable for understanding the nature of the catch data and interpreting assessment model out output for these stocks. Much of the dynamics of these stocks and the start of the only survey data are from this time thus catch data here can have a considerable influence on assessment model fits. Notably the year-class from the early 1980s supported much of the fishery and following this cohort in models strongly determines many of the production parameters attributed to this stock presently. It is therefore important to understand how this cohort evolved through time including how it was fished in order to come to reasonable production scenarios for these redfish stocks which will affect both reference points and projections.

Finally, it is important to note that the fishing industry in this period was not doing more than they were allowed or instructed to do. Individual industry players felt somewhat powerless to curb their own actions faced with the futility of another just taking over where they stopped in a competitive fishery. All industry participants from that time note that with the three large year-classes of redfish coming (2011,12,13) that midwater trawling gear as well as seasons need to be tightly regulated to ensure a sound, long-term conservation and economic exploitation strategy for these stocks.

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